R E P O R T R E S U M E S

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OPERATING, REPAIRING, AND MAINTAINING SMALL POWER EQUIPMENT. HORTICULTURE-SERVICE OCCUPATIONS, MODULE NO. 10.

OHIO STATE UNIV., COLUMBUS, CENTER FOR VOC. EDUC.
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ONE OF A SERIES DESIGNED TO PREPARE HIGH SCHOOL STUDENTS FOR HORTICULTURE SERVICE OCCUPATIONS, THIS MODULE HAS AS ITS MAJOR OBJECTIVE TO DEVELOP A PROFICIENCY IN THE OPERATION, MAINTENANCE, AND REPAIR OF SMALL POWER EQUIPMENT USED IN HORTICULTURAL ENTERPRISES. IT WAS DEVELOPED BY A NATIONAL TASK FORCE ON THE BASIS OF DATA FROM STATE STUDIES. SUBJECT MATTER AREAS ARE (1) SMALL GASOLINE ENGINE ADJUSTMENT, MAINTENANCE, AND REPAIR, (2) SMALL POWER EQUIPMENT MAINTENANCE, (3) LAWN MOWER OPERATION, (4) ROTARY TILLER OPERATION, (5) SOIL SHREDDER OPERATION, (6) AERIFIER OPERATION, (7) SOD CUTTER OPERATION, (8) GARDEN TRACTOR OPERATION, (9) PESTICIDE APPLICATOR OPERATION, AND (10) CHAIN SAW OPERATION. SUGGESTIONS ARE INCLUDED FOR INTRODUCTION OF THE MODULE, SPECIFIC UNIT OBJECTIVES, SUBJECT MATTER CONTENT, TEACHING-LEARNING ACTIVITIES, INSTRUCTIONAL MATERIALS AND REFERENCES, AND CRITERIA FOR STUDENT EVALUATION. THE MODULE IS SCHEDULED FOR 25 HOURS OF CLASS INSTRUCTION, 75 HOURS OF LABORATORY EXPERIENCE, AND 50 HOURS OF OCCUPATIONAL EXPERIENCE. TEACHERS WITH A BACKGROUND IN HORTICULTURE MAY USE THIS GUIDE TO PREPARE UNITS FOR LESS ABLE HIGH SCHOOL STUDENTS WITH OCCUPATIONAL GOALS IN ORNAMENTAL HORTICULTURE. THIS DOCUMENT IS AVAILABLE FOR A LIMITED PERIOD AS PART OF A SET (VT 000 619 - 000 631) FOR $7.25 FROM THE CENTER FOR VOCATIONAL AND TECHNICAL EDUCATION, THE OHIO STATE UNIVERSITY, 980 KINNEAR ROAD, COLUMBUS, OHIO 43212. (JM)

OPERATING, REPAIRING, & MAINTAINING SMALL POWER EQUIPMENT

One of Twelve Modules in the Course Preparing for Entry in
HORTICULTURE - SERVICE OCCUPATIONS

Module No. 10

The Center for Research and Leadership Development
in Vocational and Technical Education

The Ohio State University
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Columbus, Ohio, 43212

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August, 1965

M E M O R A N D U M

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DATE: August 7, 1967

RE: (Author, Title, Publisher, Date) Module No. 10, "Operating, Repairing, and Maintaining Small Power Equipment," The Center for Vocational and Technical Education, August, 1965.

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(3) Utilization of Material:
Appropriate School Setting High School
Type of Program High school class in horticulture--service occupations
Occupational Focus Service workers at nurseries, garden centers, greenhouses, etc.
Geographic Adaptability Nationwide
Uses of Material Instructor course planning
Users of Material Teachers

(4) Requirements for Using Material:
Teacher Competency Background in horticulture
Student Selection Criteria Designed for the less able high school student, goal in horticulture service occupations.
Time Allotment Estimated time listed in module. (P)

Supplemental Media --
Necessary x
Desirable
(Check Which)

Describe Suggested references given in module. (P)

Source (agency)
(address)

OPERATING, REPAIRING, AND MAINTAINING SMALL, POWER EQUIPMENT

CONTENTS

OPERATING, REPAIRING, AND MAINTAINING SMALL, POWER EQUIPMENT

Major Teaching Objective

To develop proficiency in the operation, maintenance, and repair of small, power equipment used in horticultural enterprises.

Suggested Time Allotments

At school

Class instruction	25 hours	
Laboratory experience	75 hours	
Total at school		100 hours
Occupational experience		50 hours
Total for module		150 hours

Suggestions for Introducing the Module

Teacher discussion can be used to bring out the following points concerning small, engine-powered equipment as used in horticulture. Modern horticultural practices require extensive use of such equipment. Many tasks that previously were laborious can now be completed quickly with less human fatigue and more efficiency. In many situations, properly handled power equipment can do a job better than can be done by hand methods.

The value of any piece of equipment at a particular job site is determined by the following factors:

1. Proper type of equipment for the specific job
2. Skillful operator
3. Properly maintained equipment

Too often "American ingenuity" is carried to the point where workers attempt to use power equipment on jobs for which they are not suitable. Although the job may be accomplished, it may be poor or inefficient. For example, a small, front tine, rotary tiller is often used to remove old sod prior to reseeding or resodding. The machine, usually too light to loosen the sod satisfactorily, is also often fatiguing and hazardous to operate.

A sod cutter, specifically designed for removing sod, can do the job much more rapidly, eliminating hand-picking of bits of sod, and will considerably minimize safety hazards.

Although small, engine-powered equipment can often be used for jobs other than those for which it was designed; improper use gives unsatisfactory results, poses safety hazards, and may cause premature equipment breakdown or damage.

Some power equipment, such as certain power mowers, can be operated properly after only a few minutes of instruction. Other equipment, such as sod cutters and some sprayers require more extensive training to develop the skill necessary for their proper operation.

Proper operation of small, engine-powered equipment requires a sound knowledge of both the piece of equipment and the horticultural crop or product on which the equipment is used. Proper adjustment depends on the operator's understanding of both the adjustment or handling procedures for the machine and the characteristics of the crop or product being worked. As examples, depth of cultivation is different for carrots than for rhododendrons, and sprayer coverage adjustment is different for applying selective herbicides than for applying a general fungicide.

A piece of powered equipment rapidly loses it value as a labor saving device when it does not function properly. Not only could productive time be lost, damage caused to the crop or product, but safety hazards to operators could result.

Good maintenance of power equipment is essential to derive the full advantage of its use.

To create interest in this module, assemble several pieces of power equipment at the school, or arrange for a trip to a cooperative, local equipment dealer. Have students identify the pieces of equipment and describe what they are designed to do. If possible, have an experienced operator adjust, start, and operate each piece of equipment. Allow each student, under careful supervision, to guide or handle each piece of equipment while it is in motion or operation. During these procedures, point out the care needed in adjustment, the skills needed for operation, and the safety practices necessary for each piece of equipment.

A safety film concerning equipment operation would be appropriate at this time for introductory purposes.

Competencies to be Developed

I. To adjust, maintain, and repair small gasoline engines properly

Teacher Preparation

Subject Matter Content

In presenting the subject matter in this competency, it is suggested that the teacher use materials such as those developed by the Briggs and Stratton Company or material from the module

entitled "Adjustment, Maintenance, and Repair of Small Gasoline Engines," which is part of the series in Agricultural Machinery--Service Occupations available from The Center for Research and Leadership Development in Vocational and Technical Education.

Suggested Instructional Materials and References

1. Adjustment, Maintenance, and Repair of Small Gasoline Engines.

2. Repair Instruction, II, Briggs and Stratton

II. To develop the ability to maintain small powered equipment

Teacher Preparation

Subject Matter Content

Small, engine-powered equipment quickly loses its value if it is not carefully maintained. Profitable use of the equipment depends on trouble free operation on the job. While no equipment, no matter how well maintained, can be guaranteed not to break down on the job, "down time" can be extremely short if a careful maintenance program is followed. Human and livestock health care is of a preventative nature. Equipment maintenance should be similar.

Preventive maintenance can be described as consisting primarily of two things:

1. Periodic equipment inspection to discover situations which may lead to equipment breakdown.

2. Upkeep to minimize wear or to remedy potential trouble.

Regularly used equipment should always be checked by the operator. Should he notice any slight malfunction, he should correct it before further trouble develops. The operator should see that field maintenance is carried out regularly.

Usually not enough horticultural equipment is operated by a horticultural business to warrant hiring a full-time field mechanic or serviceman. The operator has the responsibility to check oil, apply grease, and perform other maintenance when needed. In some instances, this may be required every few hours. At the end of the day, the operator should make an overall check and properly service his equipment. This will make the equipment ready to use the next day or on any future date is may be needed.

A regular program of shop maintenance should be carried out on each piece of small engine powered equipment. Small engines have prescribed periods of operating time after which oil should be drained and replaced. At that time a general check of the equipment is in order.

Before beginning operation of a small, engine-powered piece of equipment, the following should be checked:

1. Fuel
2. Engine oil level
3. Oil level and air filter
4. Belt tension
5. Chains, oil if necessary
6. Moving parts requiring frequent applications of grease or oil
7. Gearboxes
8. Implement adjustments

During operation, the operator should constantly watch for any slight malfunction. Often a change in the sound of the machine when in operation will indicate the beginning of trouble. A skilled operator can tell by the sound of the machine if everything is in good working order. If equipment is used for long periods during the day, regular shutdown for preventive maintenance practices are advisable.

When equipment has been shut down for the day, it should carefully be checked and readied for the following day's operation.

1. Fuel - Fill the fuel tank. Moisture condenses more rapidly in a partially empty tank as the air cools.
2. Oil - check the oil level and add oil as required. The oil should be changed periodically.
3. Transmission case - check the lubricant level; adding or changing the lubricant as necessary.
4. Oil filter - clean and check the oil level
5. Chains - apply oil to chains at regular intervals. Check the condition of the links.

6. Belt condition - check belts for excessive wear and for proper tension.

7. Moving parts - grease all moving parts

8. Cutting surfaces - clean and check cutting surfaces of plows, cultivator tines and mowers for sharpness. Cover cutting surfaces with used oil or grease if the machine is to sit out in the weather or not be used over a period of time.

9. Adjustment - check machine to be sure that all operating parts are in correct adjustment.

10. Bolts - inspect the machine for missing and/or loose bolts.

11. Damaged or broken parts - determine if any parts have been damaged to the extent that machine operation will be impaired. Replace these and all broken parts to insure proper operation.

12. Machine cleanliness - clean off accumulated dust and dirt regularly.

When small, engine-powered equipment is put away for the off-season, give special care to provide the maintenance necessary to insure rapid starts the following season.

Small engine-powered equipment is most valuable when operating properly. Proper preventative maintenance helps insure proper operation.

The following general procedure should be used. However, check the operators' manual for specific maintenance procedures which may be needed for a particular piece of equipment.

1. Before beginning the check, disconnect spark plug wire to eliminate a possible accident.

2. Using wire brushes, scrapers, rags, and chemical de-greasers, clean the entire machine. Use chemicals only outdoors.

3. Clean air filter. Rinse with gasoline or other solvent, wipe dry, and refill with oil. If the air filter has a dry element, replace with new element according to manufacturing recommendations.

4. Check carburetor for sediment. Remove and check if necessary.

5. Re-connect spark plug wire and run engine for five minutes. Stop the engine, remove the spark plug wire and drain the crankcase oil. Fill with new oil as recommended by the manufacturer.

6. Drain gas tank. Reconnect spark plug wire, start the engine, and run until the tank and carburetor are free of gasoline.

7. Remove spark plug and pour a teaspoonful of oil into the cylinder. Turn the flywheel to distribute oil. Replace the spark plug with a new one.

8. Adjust and/or sharpen any blades or implements.

9. Grease or oil any moving parts.

10. Wipe a light coating of oil over bare metal parts.

11. Store in a protected, dry place.

Suggested Teaching-Learning Activities

1. Have students make a list of maintenance procedures to be performed regularly while different types of equipment are in operation under daily, periodic, and seasonal conditions as called for in the operator's manual.

2. Assign a pair of students to a piece of machinery. Have them determine what maintenance should be carried out and have them do it.

3. Have students visit, and observe a golf course or grounds equipment mechanic at work in his shop. Have the mechanic explain the regular maintenance procedures carried out. Have him explain his maintenance record for each piece of equipment.

4. Assign students to prepare a piece of equipment for storage or taking out of storage, as the situation warrants.

5. Discuss various pieces of equipment and note the parts requiring regular maintenance.

Suggested Instructional Materials and References

Instructional materials

1. Various pieces of small, engine-powered equipment

2. Tools and supplies needed for maintenance

References

Various operators' manuals

Suggested Occupational Experiences

Employment in a horticultural enterprise where small engine-powered equipment is used. This would bring the student into close contact with equipment operation. The student should:

1. Observe and learn to identify the various pieces of equipment and how they are used.
2. Learn to operate certain pieces of small engine-powered equipment.
3. Learn to handle all routine maintenance procedures for equipment operated.

III. To operate lawn mowers safely and effectively

Teacher Preparation

Subject Matter Content

Power mowers can be divided into three general categories: (1) reel, (2) rotary, or (3) sickle bar.

REEL MOWERS. A reel mower is basically a common hand push mower powered by a small gasoline engine. As the mower moves forward, the revolving blades slide past the bed knife (see sketch) and cut the grass blades.

Reel mowers used on bluegrass and similar grasses have five revolving reel blades. Reel mowers used on the bent type grasses have seven or nine blades to provide a smooth, even cut on these fine-bladed grasses.

Reel mowers minimize the tendency of scalping, or extremely close cutting on the high spots of an uneven lawn. Repeated scalping will result in a weak turf at those spots.

The procedure for adjusting height of cut varies for each make of reel mowers. In general the following procedures apply:

1. Disconnect the spark plug wire from the spark plug and place it in a position where it is impossible for a spark to jump an air gap to the plug, possibly causing accidental starting.

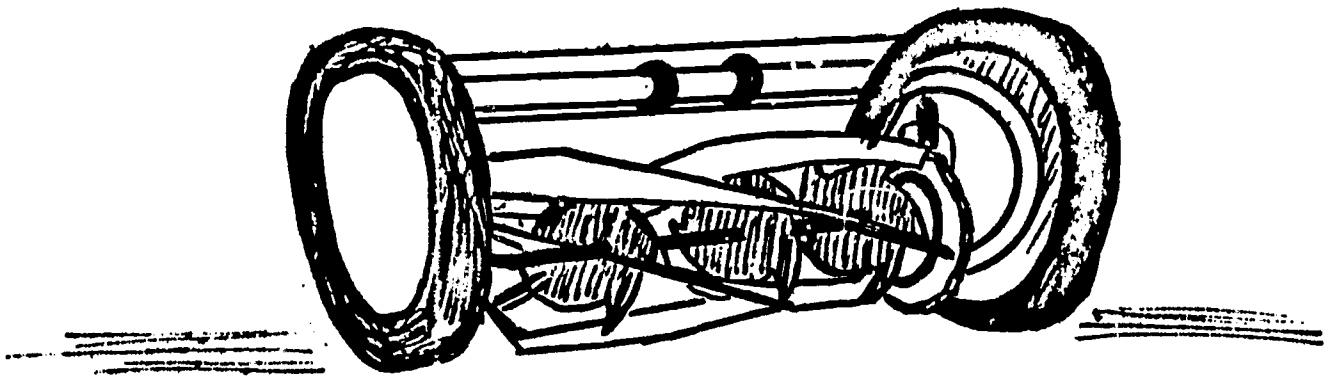
2. Place mower on a perfectly flat, hard surface, such as a concrete walk or solid workbench.

3. Adjust the bed knife to the proper height by manipulating the height adjusting set screws or by adjusting the wheel height.

4. Check to see that the adjustment procedure has not distorted the bed knife. Rotate the reel and check the clearance between reel blades and bed knife for the entire length of each of the reel blades. This clearance should be uniform along the length of each blade. If this cannot be achieved through adjustment it will be necessary to utilize special equipment to grind the blades to obtain the desired clearance.

6. Adjust handle height to suit the operator.

The Power Reel Mower



Sharpening mowers requires special equipment and should be left to a specialist.

Rotary Mowers. Rotary mowers have a vertical shaft engine mounted on a housing which encloses a horizontally revolving blade. The blade may be mounted on the engine shaft, or one or more blades may be mounted on vertical jackshafts. As the mower moves forward, the blade revolves at very high speeds lifting and cutting off the grass blades. Rotary mowers are generally simpler in construction than reel mowers.

Scalping or extremely close cutting of high spots on uneven turf, can easily occur through careless operation. Because the rotary mower is relatively square in design, the wheels may pass over a high spot and drop into a lower area during mowing and cause the blade to drop near to or hit the soil surface. Excessive scalping may severely damage the turf.

Rotary mower adjustment varies in detail according to the make; but the following general procedures usually apply:

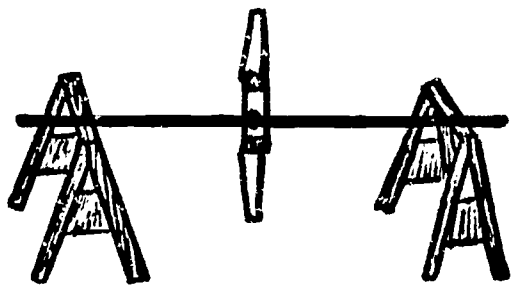
1. Place mower on a perfectly flat, hard surface, such as the concrete walk or a solid workbench. Remove spark plug wire so as to prevent the possibility of accidental starting which might result in serious injuries.

2. Adjust mower blade to proper height by adjusting wheel height in relation to the housing. Be sure to check the blade height and not the housing height since the blade is not level with the lower edge of the housing.

3. Adjust mower handle height to suit operator.

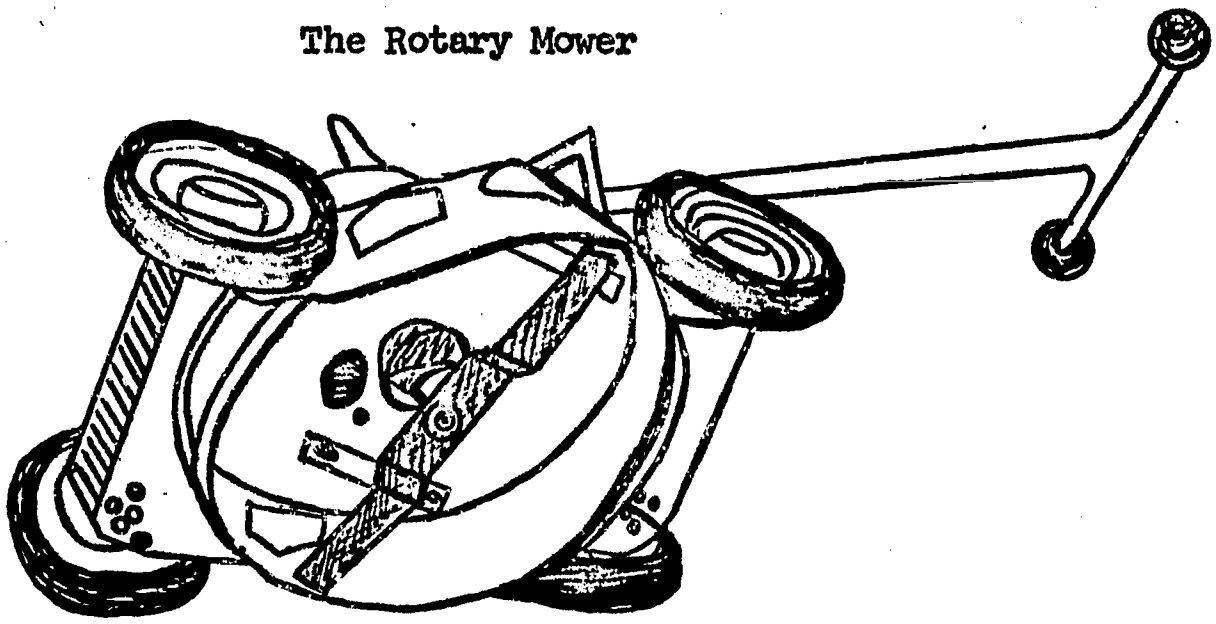
Rotary mower blades should be sharpened regularly, since a dull blade rips, instead of cutting the grass. Before removing the blade for sharpening, disconnect the spark plug wire. The blade may be sharpened by grinding or by filing. Prior to remounting, the blade must be balanced. The blade is mounted on a rod which is the same diameter as the hole in the blade. Place the ends of the rod on a hard, perfectly flat surface with room for the blade to revolve freely. Two short pieces of 2" x 4" hard wood would work. After resting the ends of the rod on the 2 x 4's, the blade should remain level. If the blade is not balanced, grind or file the heavier end until perfect balance is achieved.

Balancing the Sharpened Rotary Mower Blade



Individual knives mounted on a base plate should be weighed after grinding to check their balance. If necessary, metal may either be ground off the back of the knife or holes may be drilled in the back of the knife to remove excess weight so that perfect balance can be achieved.

The Rotary Mower



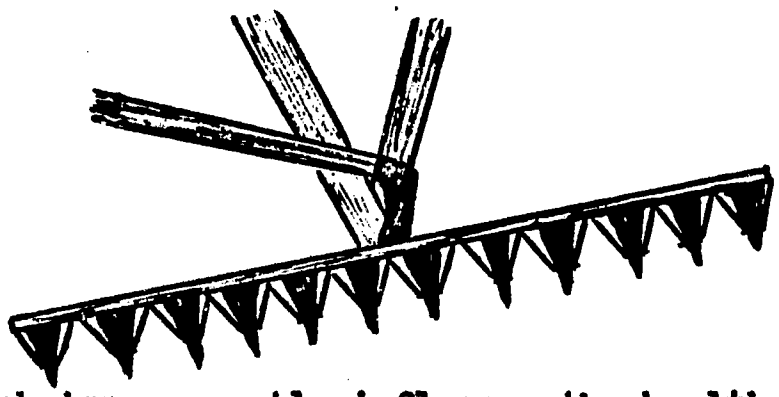
Sickle Bar Mowers. Sickle bar mowers are used to cut overgrown turf or heavy weeds. They generally do not cut neatly enough for use on home, industrial, or recreational lawns.

Sickle bar mowers consist primarily of a cutter bar and knife. The knife is a narrow steel bar to which several triangular-shaped, sharp, knife sections are riveted. The knife is driven by a pitman rod through a series of guards and over numerous wear plates. As the cutter bar moves forward, grass blades are cut by a scissor-like action as the knife moves rapidly back and forth over the wear plates.

The sickle cutter bar is usually mounted on and powered by a garden tractor or is permanently mounted and powered by a specially-designed power unit.

Height-of-cut adjustment is not present on some sickle bar mowers. On other makes, height adjustment is made by raising or lowering a steel "foot" which rides on the ground and keeps the mower at a set level.

The Sickle Bar Mower



Correct mowing techniques greatly influence the health, vigor, and appearance of a lawn.

Leaves of the grass plant are essential to producing food for plant growth. When cut off too low, the food producing section of the leaf is lost and turf vigor quickly declines.

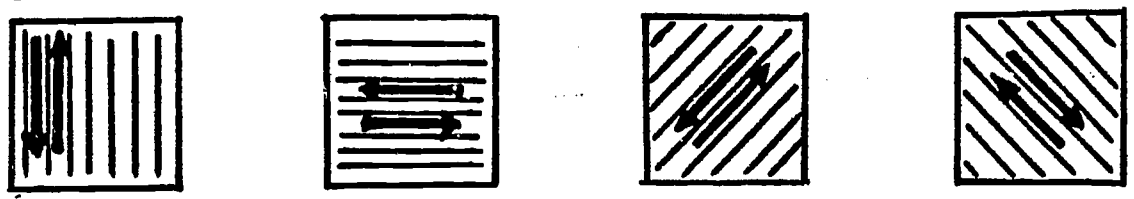
Grasses similar in height to the bluegrasses should be cut to a height of $1\frac{1}{2}$ to 2 inches. Low growing grasses of the creeping bent types should be mowed to a height of about $\frac{1}{2}$ to 3/4 inch.

Frequency of cutting is as important as the height of cut. Lawn grasses should be cut often enough so that no more than $\frac{1}{2}$ inch of leaf surface is removed at any one time. When more than that amount of leaf surface is removed, the plant is "shocked" and requires several days to recover.

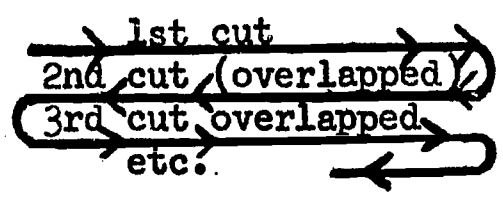
If the lawn is mowed frequently enough, clippings need not be removed. They filter down to the surface of the soil and act as

a beneficial mulch for the turf. If the clippings are excessively long, they must be removed since they may smother the grass. Under certain conditions, some lawns develop excessive "thatch," dense mats of dead grass and clippings, at the soil surface. Under such circumstances, all clippings should be removed.

The mowing pattern should be varied each time the lawn is mowed to eliminate low spots, corrugations, and some matting. The changed lawn patterns created by changing mowing directions also enhance the overall landscape appearance. The following mowing patterns are suggested:



Overlapping each opposing cut improves the lawn appearance. Mowing in the opposite direction of the previous cut and overlapping past the wheel mark of the previous cut can raise grass that may have been matted down by the wheels and permit it to be cut.



Safety should be foremost in the mind of any equipment operator. He should know his mower and its capabilities and should attempt only jobs for which the equipment is designed. Except for adjusting the carburetor, he should never place his hands in or near moving parts, nor allow anyone else, especially children, to be nearby when the engine is running. When the engine is stopped for cleaning or repairs, the spark plug wire should be removed to eliminate the hazard of accidentally starting the engine. The operator of a rotary mower should be constantly on guard against running over articles such as glass or stones which could be thrown by the blades of the mower, since such debris can cause severe injury to people or pets.

Suggested Teaching-Learning Activities

1. Bring in to the shop various types and makes of lawn mowers. Have students identify them as to mower type and engine type. Where possible have students bring mowers from home.

2. Demonstrate height of cut adjustment procedures for available makes of mowers. Teach students to adjust each

mower to the various heights specified by the teacher. Rotate students so that each student has an opportunity to work on each mower. Use mowers brought in by students if insufficient school-owned mowers are availabe. Emphasize safety procedures. Make use of manufacturers' catalogs and operators' manuals.

3. Have students remove, sharpen, and balance rotary mower blades. This can be done on mowers brought from home. Emphasize safety procedures. Students should always wear safety glasses when doing any grinding work.

4. On selected, uneven, inconspicuous areas of the school grounds, demonstrate scalping as done by mowers. Have students evaluate the situation and determine which direction of mowing would minimize future damage.

5. Assign each student to cut a specifically marked section of turf with one of the available mowers. Require him to identify the type of grass, adjust the mower cutting height accordingly, and mow in a pattern suited to the terrain. He should determine whether clippings can remain or must be removed. Stress safety.

6. Have students draw the possible mowing patterns for a given plot.

7. Demonstrate how the mower wheels mat down grass, especially that which is excessively tall or wet. Mow some overlap strips in the same direction and some overlap strips in opposite directions with the mower. The following day observe the grass in the wheel marks. Point out that opposite-overlap strips reduce the amount of grass left uncut due to being pushed down by mower wheels.

8. Demonstrate how mowers should be cleaned, adjusted, and operated safely. Devote adequate instructional time on all aspects of mower adjustment and safe operation.

9. Have students bring in the family mower to be repaired and reconditioned.

Suggested Instructional Materials and References

Instructional materials

1. An assortment of various types of power mowers
2. Required tools for mower adjustment
3. Grinder and/or files for sharpening rotary mower blades

References

1. A collection of various mower manufacturers' catalogs and operators' manuals

2. Conover, Grounds Maintenance Handbook, pp. 167-169

IV. To operate rotary tillers safely and effectively

Teacher Preparation

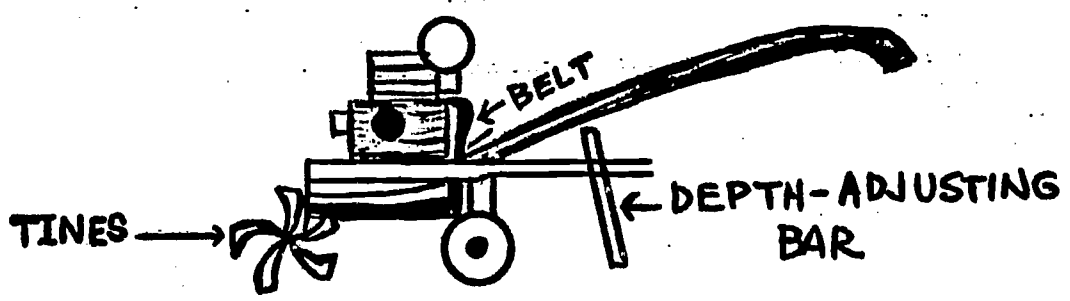
Subject Matter Content

Rotary tillers are classified into two categories according to the arrangement of the tilling tines. Front tine tillers are those which have the tines located in front of the wheels. Rear tine tillers have the tines located behind the wheels.

Front tine tillers are generally designed for light-duty work and are often used for cultivating. In a loose soil they may do a satisfactory job of tilling to a depth of several inches. The machines usually are not heavy enough to till deeper on loose soils or to till heavy clay-packed soils with heavy vegetative cover.

Front tine tillers do not have power wheels. The rotation of the tines causes the tiller to move forward. Some control can be exerted over rate of forward motion by adjusting the depth bar. (See sketch of front tine rotary tiller.) If the tiller must be held back to do a proper job of tilling, the depth bar should be lowered to cause the tines to dig deeper and slow the rate of forward speed. If the tiller digs deeply and does not move forward, the depth bar should be raised. Different soil conditions also determine the adjustment of the depth bar.

The Front Tine Rotary Tiller



Rear-tine rotary tillers are designed for medium to heavy duty work. Excellent tilling can be done to depths of about eight inches in a variety of soils having various amounts of vegetation or organic matter. This type of tiller can thoroughly mix organic matter into the soil.

Rear tine tillers have powered wheels and usually a reverse gear. Power can be transferred to either the wheels or the tines. Rate of forward speed is controlled by selection of proper gear and throttle setting.

Tilling depth on rear tine tillers is also adjusted by a depth bar which is usually located behind the tines. The bar is raised for increased tilling depth and lowered for decreased depth.

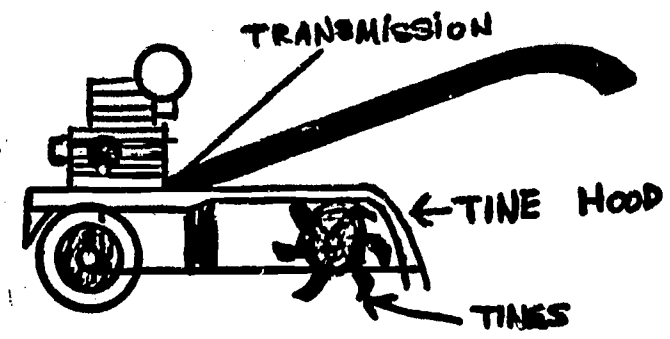
Since rear tine tillers are often used on heavy or packed soils, several points of operation should be noted. The following operational procedures should be observed:

1. Rotary till when soil moisture is correct. Use standard method of squeezing a handful of soil to determine moisture content. When the soil ball flakes and cracks, soil has the correct moisture content for tilling.

2. First run tilling depth should be no more than one to two inches. Increase depth for each additional pass.

3. Final tilling passes should be at right angles to previous ones to break down lumps further.

The Rear Tine Rotary Tiller



The handling procedures for front and rear tine tillers are considerably different. Each type can pose safety hazards to careless operators. Before starting any tiller, check to see that all clutches, or belt tension pulleys are disengaged. The load on the engine may be great enough to prevent the engine from starting if these clutches were engaged. If the engine should start while the clutch is engaged, the machine may get away from the operator and cause personal injury or property damage. Even if the engine does not start while the clutch is engaged, a sharp pull on the starting rope may upset the machine or injure the operator.

Rear tine tillers present added hazards to the operator. Power to the tiller tines should be disengaged whenever the tiller is not being used for tilling. This includes turning the machine around when moving it from one site to another.

Suggested Teaching-Learning Activities

1. Bring in both a front tine and rear tine tiller. Discuss the design of each. Point out the type of belt, gear, or transmission arrangement used to power the tine and/or the wheels.

2. Identify and discuss each part of the machine.

3. Demonstrate proper tilling procedures. Have students practice with each machine, beginning on loose soil and progressing to a heavily-packed soil requiring repeated passes to reach the desired tilling depth. Allow each student sufficient time on each machine to become accustomed to the particular peculiarities of each. A teacher-coached demonstration given prior to the actual operation of the machines by the students is recommended.

4. To demonstrate the possible danger of getting a shirtsleeve or pant leg caught in the tiller tines, place an old shirt outstretched on the ground and till onto the shirt beginning at one of the sleeves. The shirt probably will be quickly wound around the tines and require extensive manipulation or cutting to be removed.

5. Demonstrate and have student adjust depth of tilling on each of the tillers.

6. Provide sufficient practice time so that the students will become competent operators of these tillage machines.

Suggested Instructional Materials and References

1. Instructional materials

   a. Front tine tiller

   b. Rear tine tiller

   c. Photographs of various makes of tillers, cut from magazines or catalogs.

2. References

   a. Tiller manufacturers' catalogs and operators' manuals

V. To operate soil shredders safely and effectively

Teacher Preparation

Subject Matter Content

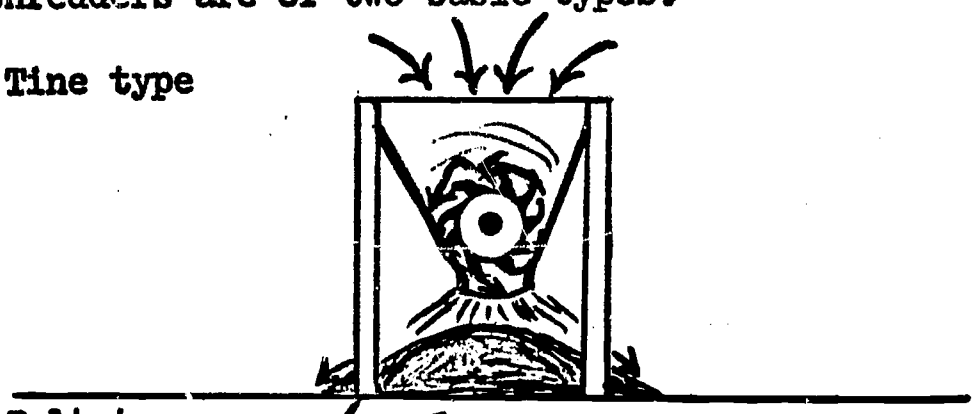
Horticultural operations involving preparing and mixing soils with soil shredders should be done by staff members capable of properly operating such equipment.

The soil shredder is a valuable machine which, if properly handled, can perform the following functions:

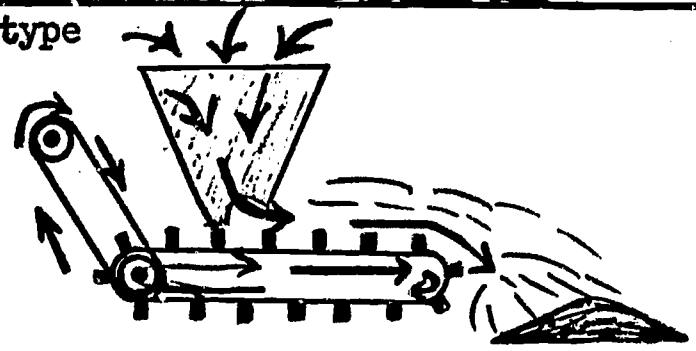
1. Shred compost
2. Mix a compounded soil
3. Separate trash from desirable soil
4. Separate soil according to particular sizes
5. Shred dry leaves and other tight, dry, organic matters
6. "Fluff up" or loosen a packed soil

Power soil shredders are of two basic types:

1. Tine type



2. Belt type



The tine type shredder has a series of tines mounted on a shaft similar to the tine shaft of a rotary tiller. This shaft is powered by a belt driven by an engine or motor, and the tines revolve at a high speed. Soil or organic material is introduced through the hopper. The soil is broken into finer particles as it hits the rapidly revolving tines and is discharged from the machine. Certain tine shredders have discharge openings only on the bottom. End opening shredders may be aimed to throw the soil into the bin.

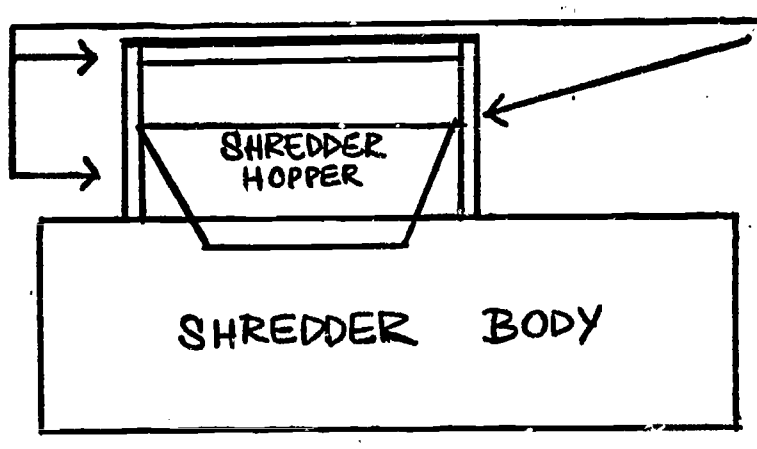
Belt type shredders have a heavy belt which rotates over two rollers. One of the rollers is connected to an engine or motor. to operate the shredder belt. The shredder belt has raised bars attached to it which break the soil or organic matter into smaller sizes and discharges it out the end of the machine. Larger lumps or particles are held back by a hanging metal gate or heavy flap until repeated encounters with the belt bars break them into smaller particles and allow them to move out of the machine. (See sketch)

Belt type shredders do not effectively shred dry leaves and other similar organic matter. Material to be shredded should not be so wet as to cause the machine to load up and not shred effectively. Overloading may also damage the power unit.

Material put into the shredder should be checked for large or otherwise dangerous debris. Heavy wire, steel, or iron articles, glass, or large stones can damage the machine or be thrown out and either injure the operator or bystanders, or damage nearby equipment or structures. The tine type shredder, because of the high tine speeds developed, should be handled with care for this reason.

A good safety practice is to construct a shield which overhangs the hopper of a tine type shredder. (see sketch) This minimizes kickback of stones and other debris which can cause injury to the operator or property damage if the machine is operated inside a greenhouse.

Suggested shield for tine type shredder is shown below:



3/4" boards on ends, top and on one side. One side is left open to allow shovelling in of material.

Material shovelled into the machine should be put in at a rate which the machine can handle. Two men may sometimes be assigned to shovel material into a shredder which can only handle the quantity that one man can supply. More efficient shredding and longer shredder life results when the machine is not overloaded.

Under no circumstances should hands, shovels, or sticks be placed into the hopper while the machine is running since severe injury might result. All belts and pulleys should be shielded.

Suggested Teaching-Learning Activities

1. If possible, obtain a soil shredder of each type. Substitute pictures and manufacturers' descriptive information for the unavailable type. Have students observe the shredders, noting the various types and methods of shredding.

2. Have students discuss the use and advantages of shredding. Build a shield, if necessary, for the school shredder. Refer to sketch in this material or design a different type.

3. Have students shred a variety of soil and organic matter. Evaluate the results. Determine which materials can effectively be handled by each shredder.

4. Have students shred soil or compost needed for school use. Instruct each student on correct procedure to be followed when putting material into the hopper to prevent overloading the equipment.

5. Have students label mimeographed diagrams of the two types of shredders. Have each student take a written and oral examination on safety procedures to be observed when using soil shredders prior to any actual operation of these machines.

Suggested Instructional Materials and References

Instructional materials

1. A sample of each type of shredder or photographs and literature describing the type unavailable.

2. A supply of various types of soil and organic matter to be shredded

3. Material for constructing a safety shield

References

1. An assortment of manufacturers' catalogs and operators' manuals for shredders. Consult any good wholesale equipment catalog for the names of various makes of soil shredders.

2. Conover. Grounds Maintenance Handbook, p. 170.

VI.. To operate aerifiers safely and effectively

Teacher Preparation

Subject Matter Content

Heavy traffic on a turf packs down the soil and reduces air supply to the roots of plants. Corrective procedures require the use of an aerifier to remedy this condition.

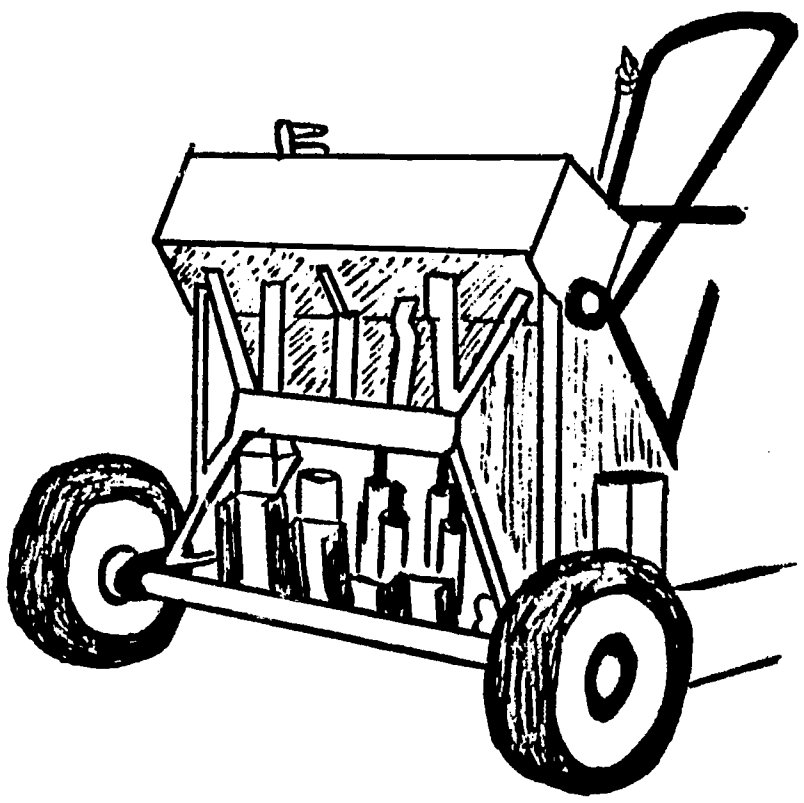
The aerifier has a series of hollow tubes, or "spoons", attached at right angles to a powered shaft. As the machine moves forward, the tubes, or spoons, are forced into the ground and pulled out bringing up a core of soil. This core is expelled from the tube onto the soil surface by a coil spring in each tube. The removal of the core of soil allows space for topdressing to filter in and allow better air penetration into the soil.

There are also prong or tine type aerifiers which simply force tines into the soil. This type of aerifier is less desirable since by forcing the tine into the ground, the soil is packed tightly along the sides of the hole. The tube or core type aerifiers minimize this problem considerably. Instead of packing the side of the hole, the soil is removed.

Aerifiers vary in size from eighteen inches in width to those over six feet in width. ..erifiers over six feet in width must be powered by a tractor if they are to operate satisfactorily.

The cores remaining after aerification can be raked up and removed or broken, with the soil being worked in as a topdressing.

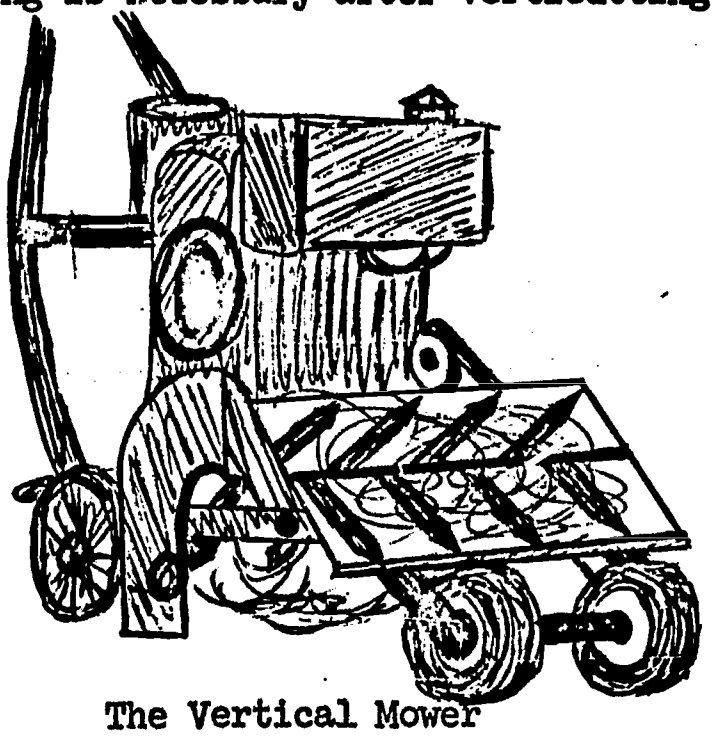
POWER AERIFIER



The vertical grass cutter, or verticutter is in a sense a hybrid between a mower and an aerifier. The vertical cutter has a series of vertically rotating mower blades which are set to a depth so that only the tip of each blade cuts through the thatch, or mat of dried grass at the soil surface. This thatch often restricts the movement of water and air. Verticutting, properly done, eliminates the problem.

When slitting the soil surface to loosen a packed condition is desirable, the machine can be adjusted by the depth adjustment roller to a minimum depth of $1\frac{1}{2}$ inches. Whenever adjustment for depth is made, each of the two adjusting screws should be raised or lowered exactly the same amount and fastened in place with lock nuts.

The cutting reel of a vertical mower should be engaged while the front of the mower is raised to allow the blades to clear the ground. Once the blades are turning freely, the drive wheels should be engaged and the front of the mower lowered slowly. Raking is necessary after verticutting to clean up the debris.



The Vertical Mower

Suggested Teaching-Learning Activities

1. If possible, have students compare an aerifier with a vertical mower. Note the aerifier tube and the vertical mower blades.

2. Have students draw a sketch showing the differences in the tubes of the aerifier as compared to the blades of the vertical mower.

3. Discuss the nomenclature and functions of the aerifier and verticutter.

4. Have students practice using the aerifier and the vertical mower on an unimportant sod area. After they develop operating skill they may aerify or verticut public lawn areas around the building. If facilities or equipment is not available at the school, plan a field trip to a golf course where the use of this equipment can be observed.

5. Have students adjust the vertical mower to various depths.

6. Emphasize the importance, from the safety standpoint, of keeping hands and feet out of moving parts. Have each student prepare a paper in which he would list the danger areas on an aerifier and a verticutter.

Suggested Instructional Material and References

Instructional materials

1. Aerifiers

2. Verticutters

3. Tools for adjusting verticutter depth

References

1. Conover. Grounds Maintenance Handbook, p. 173.

2. Manufacturers' literature on aerifiers and verticutters.

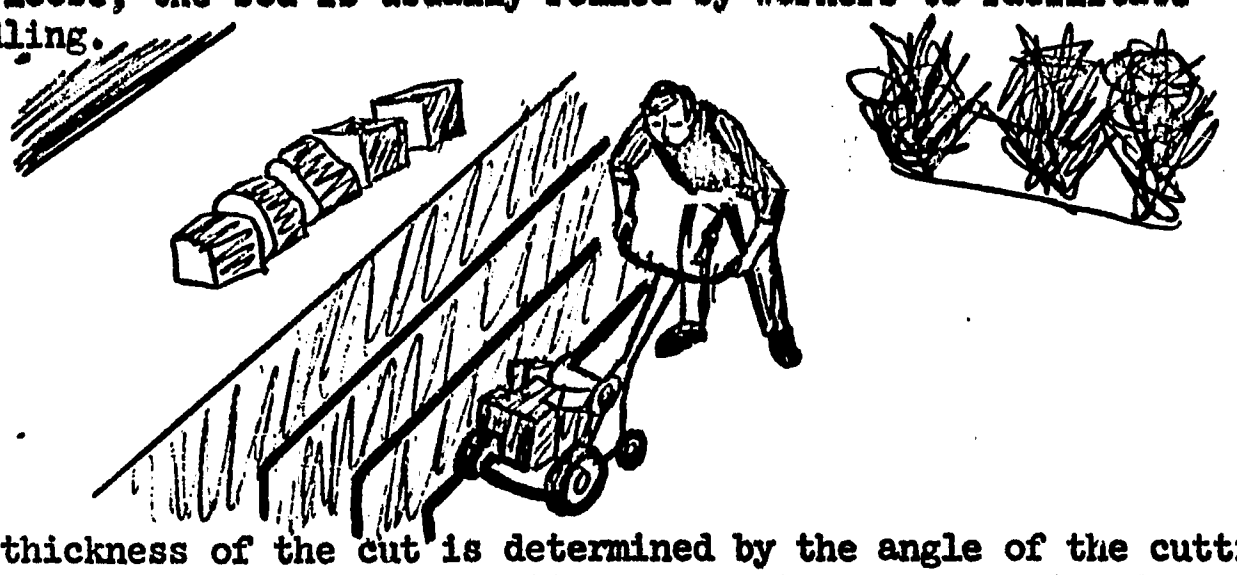
VII. To operate sod cutters safely and effectively

Teacher Preparation

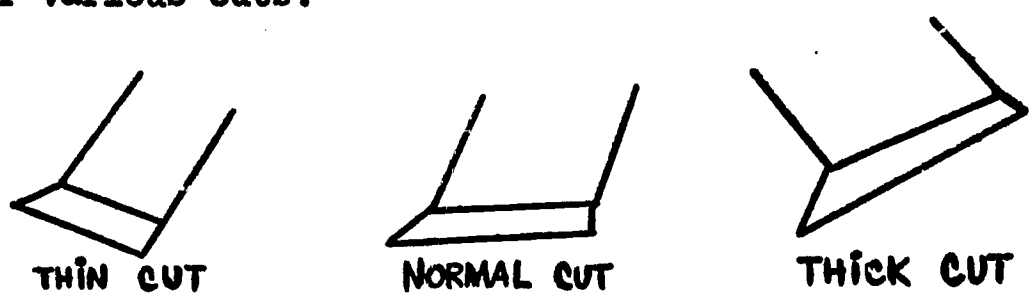
Subject Matter Content

Many landscape operations require the removal of established sod. Hand methods are tedious and produce mediocre results. A very valuable piece of equipment is the powered sod cutter. Sod can be cut to definite and regular thickness and width, insuring that it can be accurately and evenly relaid if necessary. New sod laid to replace the old will fit accurately if a sod cutter is used.

A sod cutter consists of a power unit with a blade set to cut under the sod and along the edges. As the machine cuts the sod loose, the sod is usually rolled by workers to facilitate handling.



The thickness of the cut is determined by the angle of the cutting blade. The following sketch illustrates the blade angle adjustment for various cuts:



Suggested Teaching-Learning Activities

1. Have students examine a sod cutter. Discuss the various parts. Have students draw a labelled sketch showing major parts or provide a mimeographed sketch of the machine and require the students to properly label the parts.

2. Demonstrate or have a dealer demonstrate, sod cutter operation and adjustment.

3. If possible, allow each student to operate the sod cutter. A possible practice area may be a section of the school lawn which needs to be re-sodded.

4. If possible, have each student adjust the sod cutter to cut several thicknesses of sod.

Suggested Instructional Materials and References

Instructional materials

1. Sod cutter

2. Tools for depth of cut adjustment

3. A sodded area for practice cutting

References

1. Conover, Grounds Maintenance Handbook, p. 179.

2. Manufacturers' operating and service manuals.

VIII. To operate garden tractors safely and effectively

Teacher Preparation

Subject Matter Content

The small walking or riding type garden tractor is used in a number of horticultural enterprises as well as by homeowners and hobby gardeners.

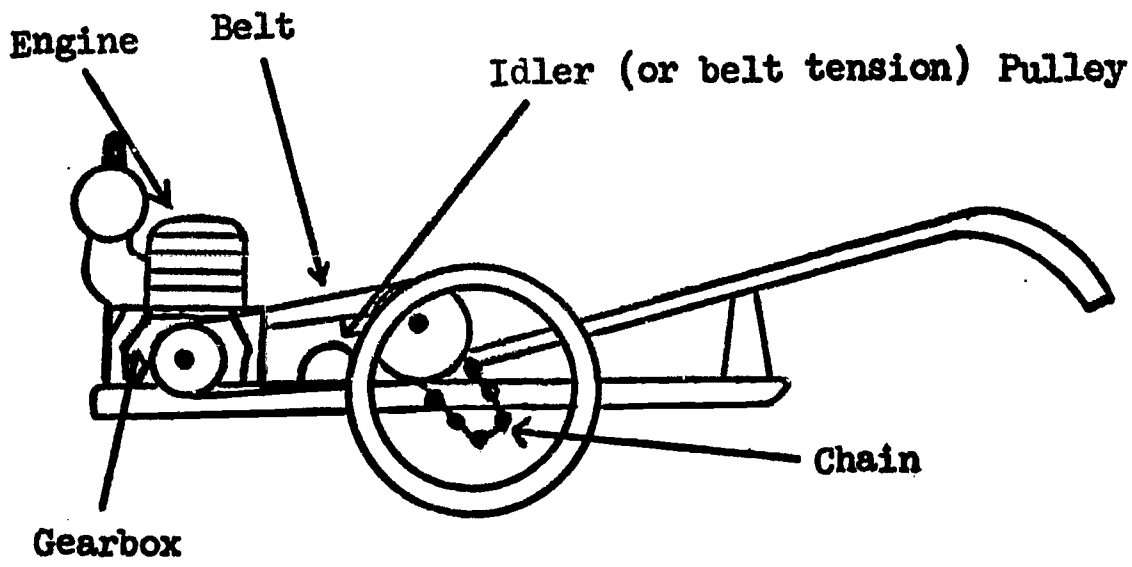
Walking type tractors have had the same basic design for a number of years, but moderate improvements such as rubber tires, have been introduced.

The basic design consists of a small gasoline engine mounted on a set of wheels attached to a pair of handles. Power is usually transmitted from the engine through a reduction gear arrangement to a jackshaft. An idler, or belt tension pulley, is mounted for the belt between the gear box and jackshaft. This provides the clutch for the tractor.

The power is transmitted from the jackshaft to the wheels by a chain or belt arrangement.

Extra pulleys may be mounted on either the gearbox shaft or the jackshaft to permit use of implements requiring power.

BASIC GARDEN TRACTOR DESIGN



A number of implements are available for walking tractors. Those requiring power, such as sickle bars or snow blowers, demand engines of high horsepower and tractors of heavier design. Many implements are simply pulled or pushed by the tractor and often can be used with tractors of lower horsepower and lighter weight.

Implements are attached to the walking tractor in two basic ways with minor modifications according to the various manufacturers. Implements which are pulled are attached by a vertical rod or "pin" which secures the tool to the tractor frame behind the engine.

Implements which are pushed by the tractor are rigidly secured to the frame in front of and under the engine with several bolts or pins.

The following implements are available for most walking tractors:

Cultivator	Seeder
Plow	Fertilizer spreader
Disc	Lawn roller
Reel mower	Rotary mower
Sickle bar mower	Sulky
Cart	Grader blade

The tractor engine can also be used to power a number of other stationary pieces of equipment, such as a small rotary cement mixer, saw, compressor, compost or soil shredder, and others.

The walking tractor is a versatile piece of equipment which, in many horticultural enterpirses, can supplement heavy equipment. Operators of small walking tractors should, however, be familiar with the equipment since too often the tractor is damaged and the operator injured where it is used for too heavy work. Quite often the walking tractor is not properly maintained since it is relatively inexpensive and possibly not used as often as larger equipment. Because regular maintenance schedules are often neglected, premature equipment failure may result.

Within the past decade, a small type of riding tractor has been developed. Most are scaled-down versions of the larger types. Horsepower ranges are from $3\frac{1}{2}$ to 10. Due to the heavier weight of the machine and the added rider weight, the unit can handle somewhat heavier jobs than most walking tractors.

While all small riding tractors can handle mower attachments, they are not riding mowers. Riding mowers are quite different from small garden tractors, in that riding mowers are built to be used for mowing grass only. The high interest in small riding tractors by homeowners with large lots has resulted in scores of different models produced by various manufacturers.

The construction varies considerably in type as well as quality. For example, some models have automotive type clutches, some centrifugal clutches, and others, a belt-pulley type clutch. Transmissions also vary considerably; some have an automotive type while others have a belt type.

The teacher should obtain a variety of manufacturers' literature giving detailed specifications of the various types of tractors.

The list of equipment available for small riding tractors is the same as that listed for small walking tractors.

Since the small riding tractors are basically a small-scale, standard tractor, several similar rules of operation should be kept in mind. All pulled equipment should be attached properly below the rear axle level to avoid tipping the tractor backwards if the load is too great. Care should be taken when operating the tractor on uneven or sloping ground to avoid turning over. The operator of a walking tractor can usually move out of the way quickly in the event of an upset, but the operator of the riding tractor is in a more precarious position.

Both walking tractors and small riding tractors can be valuable tools for a horticultural business or for the homeowner with a large lot. For maximum value, however, they should be used only to the rated capacity of the unit, on jobs for which implements are available, and in situations where their use can be justified economically.

Suggested Teaching-Learning Activities

1. Where possible, have walking and small riding tractors available for students to observe their construction and design.

2. Obtain a variety of manufacturers' literature on small tractors and use this literature to teach the students the differences, advantages and disadvantages of the different types of tractors. Have students write to specific manufacturers requesting garden tractor literature. Check and grade all letters written. This will provide practical letter-writing experience.

3. Have students compare the various pieces of equipment through the manufacturers literature. Develop charts which compare specific factors such as type of transmission and engine horsepower.

4. If equipment is unavailable for school use, arrange a trip to a dealer who can demonstrate the equipment operation.

5. If possible, have students get experience in using both walking and small riding tractors.

6. Have students obtain magazine pictures showing the various implements available for certain tractors.

Suggested Instructional Materials and References

Instructional materials

1. Walking tractors and implements

2. Small garden tractor and implements

References

Manufacturers' literature

IX. To operate pesticide applicators safely and effectively

Teacher Preparation

Subject Matter Content

Small, engine-powered pesticide applicators are regularly used in many horticultural operations. A number of horticultural operations do not cover extensive enough ground area to benefit from use of large tractor-mounted sprayers and dusters, yet are too large to economically warrant use of hand-operated equipment. Small, engine-powered sprayers and dusters are suited to these situations.

Added impetus to using small engine-powered sprayers and dusters has been given by the development of efficient ultra-small engines which permits using engine power for some knapsack-type pesticide applicators.

Most common of all small engine-powered sprayers is the hydraulic tank type. Capacity varies from ten to twenty gallons. Individual design of hydraulic sprayers varies somewhat according to manufacturer and the intended use. If large areas are to be sprayed, the sprayer may be towed behind some vehicle and have a boom attached, extending horizontally with nozzles pointed downward. The area covered by the boom is evenly sprayed. If individual plant or spot spraying is needed, the sprayer may be outfitted with a hand boom or nozzle attached to a hose. The operator could then direct the spray as needed.

When wettable powders or liquid emulsions are used in a sprayer, the spray material must be agitated to keep the powder or emulsion in uniform concentration throughout the sprayer.

Agitation is accomplished either by a paddle arrangement in the tank or by a jet or the spray material being recirculated into the tank through a by-pass arrangement.

Mist blowers are a relatively recent innovation and are becoming more commonly used in greenhouses and around outdoor ornamental plantings.

The main advantage of a mist blower is that it can discharge the pesticide in concentrated form without dilution. Most mist blowers handle both spray and dust. The material is pumped at low pressure to the discharge side of a fan. The air blasts aid in breaking up the liquid and dispersing the spray or dust at high speed, thus giving uniform coverage within its range.

Mist blowers used in horticultural situations are usually the knapsack type powered by an ultra small gasoline engine. Some larger models are wheel mounted in wheelbarrow fashion.

Power dusters have been developed which make use of the very small gasoline engines arranged to operate the fan type duster. Efficient dispersal of dust at a much faster rate is achieved.

No recommendation for use of pesticides will be discussed in this module. Specific recommendations should be obtained from current state extension publications. All chemical pesticides should be applied as directed. Exact amounts must be used for effectiveness and safety. Under no circumstances should any change be made from the official recommendations.

Specific operating procedures vary with each piece of equipment, but some general facts or procedures always apply. Careful measurement of the pesticide used is highly important. Recommendations are usually stated in terms of pounds of active ingredient or of total pesticide per acre. Horticultural use often requires breaking this amount down to smaller quantities, since smaller areas are usually involved. Practice prior to actual chemical measurement is necessary to minimize chance of error, resulting in damage or injury.

Often a full tank of materials is a hydraulic sprayer is not necessary for a specific job. Measurement is simplified by calibrating the tank in some standard unit such as a gallon, two gallon or other convenient unit, according to size of tank. This can be done by filling an empty tank with the specific amount, such as one gallon. Mark the tank measuring stick at that point and at points equal to the addition of further measured amounts. Thus

when only one gallon of spray material is needed and a ten gallon sprayer is used, the correct quantity is easily obtained.

Sprayers and dusters should be throughly cleaned after each use to reduce corrosive damage as caused by some spray materials, and to minimize contamination of future spray or dust materials used in the sprayer or duster. Always wash out sprayers or clean dusters where spray material will not contaminate nearby food or water supplies, or animal life. Follow clean-up instructions provided with each spray material to insure that proper and effective procedures are used.

Always follow safety precautions listed with each pesticide. Some materials are highly toxic if used or handled improperly.

Suggested Teaching-Learning Activities

1. If available, obtain a hydraulic sprayer, mist blower, and power duster. Have students observe and discuss the various parts of each machine.

2. Have students gain experience by using sprayers and mist blowers filled with clean water. Be sure that any sprayer previously used for applying pesticides are thoroughly cleaned before using them for practice spraying.

3. Have students practice calculation of amounts of various pesticides for various small areas.

4. Have students determine from pesticide manufacturers' literature, the cleaning procedures for sprayers in which a specific pesticide has been used. Students should report this information to the class.

5. Visit a greenhouse or other horticulture enterprise to observe spraying and dusting operations.

6. Disassemble, observe and discuss a pump from a hydraulic sprayer.

7. Use the module, Recognizing and Controlling Plant Pests and the competency in that module entitled, "To develop the ability to use proper control measures for pests affecting horticultural plants."

Suggested Instructional Materials and References

Instructional materials

1. Hydraulic sprayer

2. Mist blower

3. Powder duster

4. Extra sprayer nozzles, pumps, screens

5. Tools necessary to disassemble pump and adjust equipment

References

1. Conover, Grounds Maintenance Handbook, pp. 160-166.

2. Various manufacturers' literature

X. To operate chain saws safely and effectively

Teacher Preparation

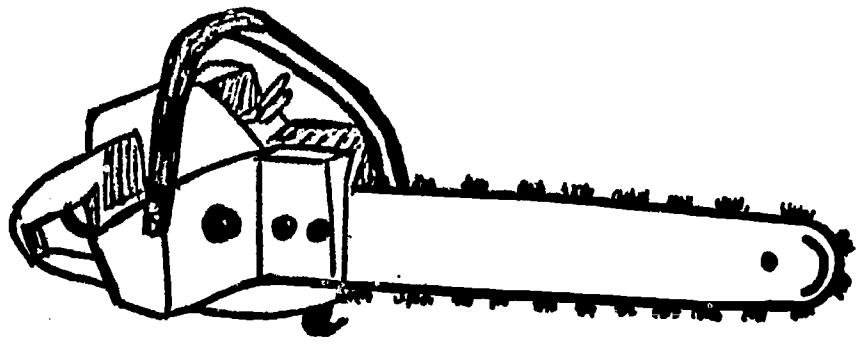
Subject Matter Content

The chain saw has revolutionized some aspects of the arborist's work. No longer does it take hours to remove a tree. In many cases the job can be done in minutes due to the speed with which a chain saw cuts. The chain saw enables a worker to cut more trees with less fatigue during a day's time.

The chain saw, like all power saws, is a potentially dangerous piece of equipment. This device is unable to distinguish fingers, arms, and legs from twigs, branches, or stems, and will cut all regardless of their nature. For this reason it is suggested that all students receiving instruction in the use of the chain saw be required to pay strict attention at all times during the instructional sessions. No horseplay can be tolerated. The students must receive constant supervision and specific instructions at all times when they have the saws in their possession. One learns to operate a chain saw by considerable practice in using acceptable techniques as demonstrated by a competent instructor.

For additional subject matter content dealing with the chain saw, secure The McCulloch Company publication, How to Use a Chain Saw and operators' manuals as made available by the various chain saw manufacturers.

The Chain Saw



Some characteristics of the chain saw:

1. The saw is designed to cut trees or limbs in a minimum of time. For example, hardwood trees up to 1¼ feet in diameter can be felled in less than a minute. Softwood trees of the same diameter can be felled more rapidly.

2. The saws are light in weight and relatively simple to operate.

3. The saw may require one or two men to operate it depending upon the type used.

Suggested Teaching-Learning Activities

1. Point out each part of the chain saw to the students and discuss the functions of each.

2. Stress the potential danger of careless operation of the saw. Do this by means of sketches, pictures, or by using a saw safety film.

3. Contact a local arborist and arrange for an expert with a chain saw to come to the school and demonstrate techniques of using the saw. The expert should stress the safety precautions which he constantly observes.

4. Have the student practice holding, turning, and otherwise maneuvering the saw with the engine of the saw stopped. Stress footwork and balance.

5. Have the students cut a felled tree or log into smaller segments under the constant supervision of the teacher or competent assistant.

6. Have the students remove undesirable limbs from trees when such practice situations are available.

Suggested Instructional Materials and References

Instructional materials

1. Chain saw
2. Logs or tree branches for practice sawing
3. Tools and supplies as required for saw maintenance

References

1. Chain Saw Service Manual, Park Maintenance
2. How to Use a Chain Saw, The McCulloch Motors Company

Suggestions for Evaluating Educational Outcomes

The primary objective of this module is to train competent operators to operate and maintain the small, power equipment used by horticultural service firms. It is believed that the student will increase his saleable skills considerably if he has learned to safely and effectively operate and maintain the various machines as described in this module.

In the final analysis, one only learns to operate machinery by actually operating the machinery. Students must be given ample time to practice with the machines once acceptable techniques have been demonstrated to them.

In checking to determine operator competence, observe such habits as:

1. Does the student try to resort to frequent, potentially dangerous, shortcuts to accomplish his assigned tasks? Examples of such shortcuts are trying to make adjustments while the machine is in operation filling the gasoline tank of a warm engine or while the engine is still running, or failing to remove stones and other debris from the path of the machine.
2. Does the student "run" the machine or does the machine "run" the student?
3. Is the student willing to learn and can he accept advice, especially that advice pertaining to safety?

4. Is the student conscientious about pre-operational, operational, and post-operational maintenance?

5. Can the student recognize the characteristic sound of a machine operating properly so that he has a basis for detecting by sound when some part of the machine is not operating properly or not functioning at all?

6. Is the student reckless when operating the machine?

7. Is the student capable of trouble-shooting to determine the causes of breakdown of the machine?

8. Is the student handy with tools?

9. Is the student mechanically inclined?

10. Would you as an employer be willing to employ the student to operate your machinery and equipment?

Sources of Suggested Instructional Materials and References

1. Conover, H. S. Grounds Maintenance Handbook, New York: McGraw-Hill Book Company, 1958. Price: $15.00.

2. Briggs and Stratton Repair Instructions, II, From MS 4750-54. Milwaukee, Wisconsin: Briggs and Stratton Corporation. No charge.

3. Chain Saw Service Manual, Park Maintenance, P. O. Box 409, Appleton, Wisconsin.

4. How to Use a Chain Saw, The McCulloch Motors Company, Los Angeles 25, California.

5. Manufacturers of power mowers, sprayers, rototillers, sod cutters, aerifiers, garden tractors and other power equipment who are serving the various geographical areas of the United States. These firms will be able to provide specifications and operators' manuals which could serve as the text references on the particular machine being studied. It is suggested that this source of information would be more valuable than that which might be obtained from some general textbook.

THE CENTER FOR RESEARCH AND LEADERSHIP DEVELOPMENT
IN VOCATIONAL AND TECHNICAL EDUCATION
THE OHIO STATE UNIVERSITY
980 KINNEAR ROAD
COLUMBUS, OHIO, 43212

INSTRUCTOR NOTE: As soon as you have completed teaching each module, please record your reaction on this form and return to the above address.

1. Instructor's Name_____

2. Name of school_____State_____

3. Course outline used: _____Agriculture Supply--Sales and Service Occupations
   _____Ornamental Horticulture--Service Occupations
   _____Agricultural Machinery--Service Occupations

4. Name of module evaluated in this report_____

5. To what group (age and/or class description) was this material presented?____
   _____

6. How many students:
   a) Were enrolled in class (total) _____
   b) Participated in studying this module _____
   c) Participated in a related occupational work experience program while you taught this module _____

7.

Actual time spent teaching module:		Recommended time if you were to teach the module again:
_____hours	Classroom Instruction	_____hours
_____hours	Laboratory Experience	_____hours
_____hours	Occupational Experience (Average time for each student participating)	_____hours
_____hours	Total time	_____hours

(RESPOND TO THE FOLLOWING STATEMENTS WITH A CHECK (✓) ALONG THE LINE TO INDICATE YOUR BEST ESTIMATE.)

	VERY APPROPRIATE	NOT APPROPRIATE
8. The suggested time allotments given with this module were:		
9. The suggestions for introducing this module were:		
10. The suggested competencies to be developed were:		
11. For your particular class situation, the level of subject matter content was:		
12. The Suggested Teaching-Learning Activities were:		
13. The Suggested Instructional Materials and References were:		
14. The Suggested Occupational Experiences were:		

(OVER)

15. Was the subject matter content sufficiently detailed to enable you to develop the desired degree of competency in the student? Yes_____No_____
Comments:

16. Was the subject matter content directly related to the type of occupational experience the student received? Yes_____No_____
Comments:

17. List any subject matter items which should be added or deleted:

18. List any additional instructional materials and references which you used or think appropriate:

19. List any additional Teaching-Learning Activities which you feel were particularly successful:

20. List any additional Occupational Work Experiences you used or feel appropriate:

21. What do you see as the major strength of this module?

22. What do you see as the major weakness of this module?

23. Other comments concerning this module:

(Date) (Instructor's Signature)

(School Address)